An Analytical Framework Intended for Congestion in Wireless Networks

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ABSTRACT: Application flows that contains congestion or video traffic is taken into account. Reducing the level of video distortion is essential per user perspective. Common link-quality-based routing metrics (such as ETX) don't account for congestion across the links of a path, as a result, they'll cause video flows to converge onto a couple of methods and, thus, cause high video distortion. We have a tendency to construct associate degree analytical framework to know and assess the impact of the network on video distortion. The framework permits us to formulate a routing policy for minimizing distortion, supported that we have a tendency to design a protocol for routing video traffic. We find based on simulations and testbed experiments that our protocol is economical in reducing video distortion and minimizing the user expertise degradation.

KEYWORDS—Protocol design, routing, video communications, video distortion minimization, wireless networks.

1. INTRODUCTION

With the arrival of smart phones, video traffic has become an extremely popular in wireless networks. per user perspective, maintaining a good quality of the transferred video is crucial. The video quality is affected by: 1) the distortion because of impression at the source, and 2) the distortion because of each wireless channel induced errors and interference. Video cryptography standards, like MPEG-4 [1] or H.264/AVC [2], define groups of I-, P-, and B-type frames that give totally different levels of encoding and, thus, protection against transmission losses. The various levels of cryptography refer to: 1) either data encoded independently, in the case of I-frames, or 2) cryptography relative to the information encoded inside other frames, as is the case for P- and B-frames combining together they form a group of pictures (GOP). Critical functionalities that's usually neglected, however affects the end-to-end quality of a video flow, is routing ancient routing protocols, designed for wireless multihop settings, are application-agnostic. User-perceived video quality will be significantly improved by accounting for application needs, and specifically the video distortion experienced by a flow, end-to-end. The schemes used to encipher video clip can accommodate a particular number of packet loss.

If the amount of lost packets in a frame exceeds a certain threshold, the frame cannot be decoded correctly. A frame loss can end in some quantity of distortion.

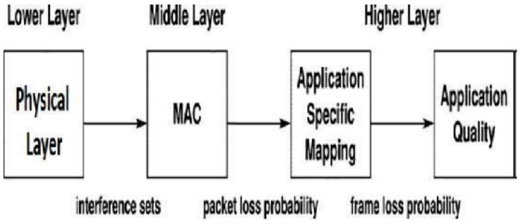

Fig.1. Multilayer approach

As one of our main contributions, we construct an analytical model to account for evolution of frame losses within the GOP as video is delivered on an end-to-end path. In our model,

we capture however the selection of path for associate degree end-to-end flow affects the performance of a flow in terms of video distortion.

Our model is constructed based on a multilayer approach as shown in Fig. 1. The packet-loss probability is mapped to the frame loss probability within the GOP. The frame loss probability is then directly related to the video distortion metric. By using the on top of mapping we discover the path from source to destination that minimizes end to end distortion.

Our contributions during this paper are as follows:

• Developing an analytical framework to find the effect of routing on video distortion:

The framework facilitates the computation of routes that are optimum in terms of achieving the minimum distortion.

• Design of a sensible routing protocol for distortion-resilient video delivery:

The practical protocol permits a source to collect distortion data on the links within the network and distribute traffic across the various paths in accordance to: 1) the distortion, and 2) the position of a frame in the GOP.

• Evaluations via extensive experiments:

We show via extensive simulations and real testbed experiments that our protocol is very effective in reducing the end-to-end video distortion and keeping the user expertise degradation to a minimum.

2. RELATED WORK

Standards just like the MPEG-4 [1] and also the H.264/AVC [2] give tips on how a video clip should be encoded for a transmission over a communication system supported layered cryptography. H.264/AVC is newest video cryptography commonplace of the ITU-T Video cryptography experts group and the ISO/IEC picture consultants group. The main goals of the H.264/AVC standardization effort have been increased compression performance and provision of a "network-friendly" video representation addressing "conversational" (video telephony) and "non-conversational" (storage, broadcast, or streaming) applications. H.264/AVC has achieved a significant improvement in rate distortion efficiency relative to existing standards. This article provides a summary of the technical features of H.264/AVC, describes profiles and applications for the quality, and descriptions the history of the standardization method.

In [3] it presents the expected transmission count metric (ETX), that finds high-throughput paths on multi-hop wireless networks. The ETX metric incorporates the consequences of link loss ratios, asymmetry within the loss ratios between the 2 directions of every link, and interference among the successive links of a path. In distinction, the minimum hop-count metric chooses at random among the different paths of a similar minimum length, regardless of the usually massive variations in throughput among those paths, and ignoring the possibility that an extended path might offer higher throughput.

In [4], an analytical framework is developed to model the effects of wireless channel fading on video distortion. We propose an accurate and fully analytical model for the distortion due to lost packet in wireless communication system. The model is, however, only valid for single-hop communication.

In [5] and [6], MDC is considered for video multicast in wireless ad hoc networks. Although these 2 papers think about the distortion since they're using MDC technique. Our approach differs not only on the way we model video distortion, however additionally on the actual fact that we tend to target LC, which is a lot of popular in applications nowadays. The Multiple Description cryptography (MDC) technique fragments the initial video clip into a number of sub-streams known as descriptions. The descriptions are transmitted on the network over disjoint paths. Even one description received at the receiver entire video is decoded however only if all the n received quality is nice. Layered coding (LC) produces a base layer and multiple enhancement layers. The improvement layers serve only to refine the base-layer quality and aren't useful on their own. Layered coding is employed because of its popularity in applications and adoption in standards. The work in [7] proposes a theme for energy-efficient video communications with minimum QoS degradation for LC. The routing scheme is predicated on a hierarchical model. To support such a hierarchy, the nodes need to be grouped in clusters, and a method of electing a cluster head needs to be executed periodically, increasing the process and data communication load of the network. In our projected theme we have a tendency to assume a flat model where all nodes within the network are equivalent and perform a similar set of tasks.

3. IMPLEMENTATION

Model Formulation

Our analytical model couples the functionality of the physical and mac layers of network with the application layer for a video that is sent from a source to a destination node. The model for the lower layers evaluates the packet loss probability through a collection of equations that characterize multiuser interference, physical path conditions, and traffic rates between source– destination pairs within the network. This packet-loss probability is then input to a model 2 to compute the frame-loss probability and from that the related distortion. The value of the distortion at a hop on the path from the source to the destination node depends on the position of the first unrecoverable frame inthe GOP.

Video Distortion Model

Our analysis is predicated on the model for video transmission distortion. The distortion is divided into source distortion and wireless transmission distortion over one hop. Instead of focusing on one hop, we tend to significantly extend the analysis for multihop by developing a model that captures the evolution of the transmission distortion on the links of a route from the source node to the destination node. Assuming that the packet losses in different frames within the GOP are independent events (likely if the fading patterns modification in between), the transition probabilities for the method, can be computed.

Video Distortion Dynamics

The value or number of the distortion at hop on the path from the source to the destination node depends on the position of the primary unrecoverable frame in the GOP. The value zero indicates that the first (I-frame) is lost, and so the full GOP is unrecoverable. a value larger than zero denotes that the corresponding P -frame is that the initial frame in the GOP that can't be decoded correctly and the value indicates that no frame has been lost therefore , yielding a distortion. The dynamics of the method and therefore of the video distortion depend upon the process.

Optimum Routing Policy

In this module, our objective is to search out the path that yields the less video transmission distortion between any source and destination. By using the analysis given, we tend to pose the problem as a random optimum management problem where the control is that the choice of future node to be visited at every intermediate node from the source to the destination. We tend to decide that this optimization problem is called as Minimum Distortion Routing (MDR) problem.

MDR problem has the following characteristics:
L 1: MDR satisfies the overlapping property, i.e.,

The problem is divided into smaller problems that retain a similar structure.

L 2: MDR satisfies the optimum substructure property, i.e., the sub-path of an optimum path is optimal for the corresponding sub-problem.

Theorem 1.: The MDR problem is resolvable by dynamic programming.

Proof: An optimization problem is resolved by dynamic programming if the problem satisfies both the overlapping and the optimum substructure properties. The proof is immediate from δ's one and 2. In essence, the εDR routing policy distributes the video frames across multiple paths and particularly minimizes the interference experienced by the frames that are at the initial of a GOP). The I-frames are longer than other frames. Their loss impacts a lot of distortion and therefore these are transmitted on comparatively interference-free paths. The upper protection rendered to I-frames is that the key contributive factor in decreasing the distortion with MDR.

Protocol Design

To calculate the answer to the MDR problem, data of the entire network is necessary. The answer to the MDR problem will be computed by the source node supported partial information relating to the worldwide state that it gathers. The source node should sample the network during a path discovery method so as to gather information relating to the state of the network. The sampling method includes the estimation of the ETX metric for every wireless link within the network. These estimates give a live of the quality of the links. The estimation method is implemented by tracking the successful broadcasting of problem messages in periodic time intervals.

The protocol uses 2 algorithms.

The ETX estimation evaluated locally within the neighborhood of a node is appended within the Route Request messages at the time of Route Discovery phase. Upon reception of this message at the destination, a Route Reply message is sent back to the source. The source node then will solve the improvement problem by using the data gathered via the sampling method described on top of

Specifically, upon receiving the Route Reply messages, the source node executes steps conferred in formula 1. Next, by invoking algorithm two produces future node within the path. This can be done to consider the mobility of the nodes a difficulty of wireless network.

The flowchart that represent the operation of the source node is shown in Fig. 2(a), while the flowcharts for Associate in Nursing intermediate node and therefore the destination node are delineated in Fig. 2(b).

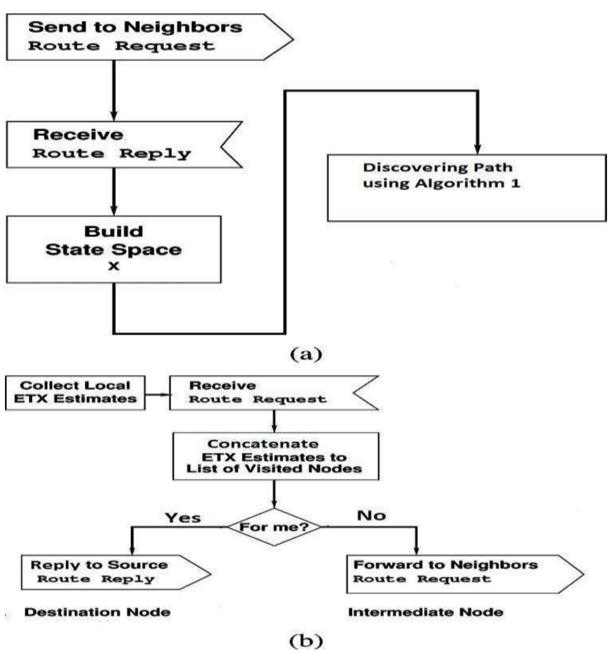

Fig. 2. Flowchart for application -aware routing. (a) Source node. (b) Intermediate and destination node.

4. RESULTS

We represent the performance gains of the proposed routing theme via extensive simulations and testbed experiments. We tend to use the network simulator ns-2. That provides a full protocol stack for a wireless multi-hop network. We tend to extend the functionality of ns-2 by implementing our projected routing theme on top of the present protocol stack. For the testbed experiments, we tend to implement our scheme using the click modular router. We implement 2 totally different strategies and experiment with each, one after another. The first technique estimates the ETX value for every link between a node and its neighbours for all the nodes within the network. The mechanism broadcasts periodically (every one s) little probe messages of size 32bytes and checks for acknowledgments from the neighbours of the node. The routing policy computes the minimum ETX path from the source to a destination and uses that path to transfer the video packets. The second technique implements the protocol defined in implementation so as to compute the routes on the wireless network that achieve minimum video distortion. We tend to use EvalVid which consists of a collection of tools for the analysis of the quality of video that's transmitted over a true or simulated network. The toolset supports totally different performance metrics like the PSNR and also the MOS.

We need to capture a log from an attempted transmission over a true network. This log indicates that frame and at what time instance was transmitted over the network. The log is fed as an input to the ns-2 simulation that plays back the video transmission, producing at the end 2 sets of statistics relating to the transmission, one for the sender and one for the receiver. By applying the EvalVid toolset on this sequence of files, we can reconstruct the video file because it is received by the destination and compare it to the initial video file. The comparison provides a measure of the video quality degradation as a result of the transmissions over the network.

4. Simulation Results

To evaluate the performance of the MDR protocol, we tend to compare it against the minimum ETX routing theme. The pair of nodes that represent the source and destination in every case are selected at random. If they happen to be neighbors, we discard that pair and repeat the method till we tend to select a source and destination that are over one hop apart. Every set of experiments is repeated 10 times, and therefore the average value is reported in every case. Our simulation experiments specialize in 3 metrics: 1) the PSNR, that is an. objective quality measure; 2) the MOS, that is a subjective quality metric; and 3) the Delay experienced by every video connection. The PSNR (Peak signal/noise Ratio) is that the most widespread objective metric to measure the digital video quality, it doesn't always capture user experience.

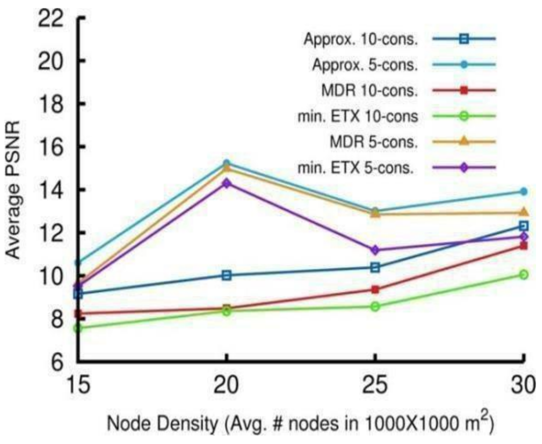

Fig. 3. Average PSNR for five and ten video connections

A subjective quality measure that tries to capture human impression relating to the video quality is the MOS (Mean Opinion Score). The result of the node density on the PSNR is shown in Fig. 3.We plot the average PSNR for five and ten synchronous video connections for various node densities and for video secret writing parameters of like with GOP size as five and Frame per second as thirty and Rate 273 kbps and Frame size as QCIF(176 X 144)pixels. We additionally plot the performance of our projected scheme (MDR). During this case, we tend to assume full knowledge of the topology so the state space where we tend to solve the optimum control problem is a superset of the state area once we collect the local estimates of ETX through the network.

4.2. Testbed Experiments

The experiment setup consists of an initial raw video processed using the H.264 encoder with a most GOP size of thirty frames. The traffic load ranges from two to twelve synchronous video flows, where the sender and receiver pairs are randomly selected. Each situation is repeated five times. To capture the effect of the ETX-based and MDR routing schemes on the user expertise, we tend to measure the average MOS because the number of synchronous video flows in the network will increase.

Fig. 4. shows that because the number of video connections within the network will increase, the average MOS for each schemes decreases. However, when the traffic load will increase, the MDR protocol computes multiple methods between the source and the destination nodes and is best in distributing the load across the network such the frames at the beginning of a GOP avoid congestion. Fig. 5.shows snapshots from video clip transmitted over the testbed below totally different traffic conditions for each the ETX and MDR protocol.

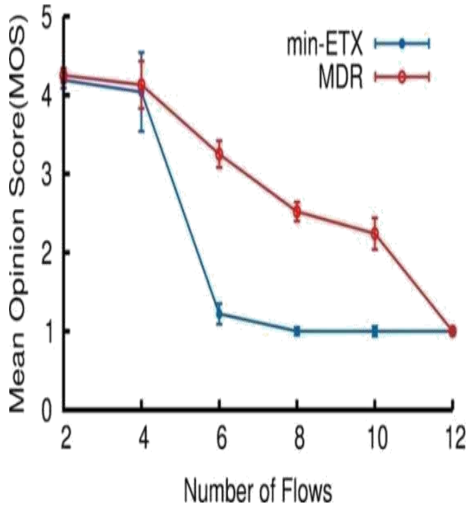

Fig. 4. Average value of MOS for a different number of concurrent video flows.

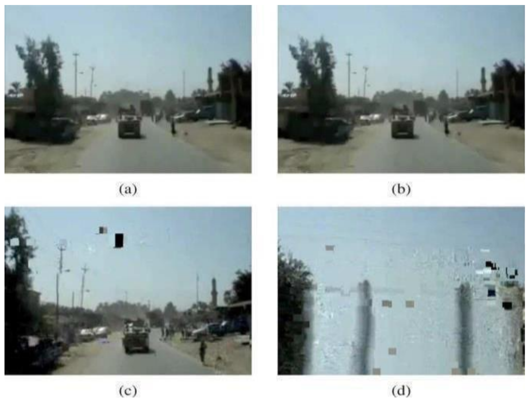

Fig. 5. User experience under different traffic loads. (a)Video snapshot—MDR (two connections). (b) Video snapshot—ETX (two connections). (c) Video snapshot—MDR (eight connections). (d) Video snapshot—ETX (eight connections).

5. CONCLUSION

In this paper, a network that primarily carries video flows is taken into account. We try to understand the effect of routing the video flow on the end-to-end distortion. To account evolution of packet loss, an analytical model is built that ties video distortion to the underlying packet-loss probabilities. Using this model, the optimum route (in terms of distortion) is decided between a source and a destination node based on dynamic programming approach. The framework permits to formulate a routing policy for minimizing distortion, based on that we tend to design a practical routing theme that's evaluated via extensive simulations and testbed experiments. Our simulation study shows that the distortion (in terms of PSNR) is decreased by 20 percent compared to ETX based routing. The future work of this paper is to minimize the users experienced degradation and to decrease the distortion more than 20%.

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